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SURVIVAL OF THE CYCAD AULACASPIS SCALE IN NORTHERN FLORIDA DURING SUB-FREEZING WEATHER

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Abstract. **The cycad aulacaspis scale insect, *Aulacaspis yasumatsui*, was accidentally introduced into southern Florida in 1996. Since its initial discovery in the Miami area, it has been noted in numerous locations throughout the state. In addition, infested plants have been reported in Alabama, California, Georgia, Hawaii, Louisiana, South Carolina and Texas. The primary method of long-distance spread is presumed to be by the transport of infested plants. While the worst infestations tend to be in warmer climates (primarily USDA zones 9 and 10), the presence of the scale in areas where temperatures regularly fall below the freezing point would seem to indicate that the Cycad Aulacaspis Scale can survive in any area where a host plant may be found. In 2001, specimens of *Aulacaspis yasumatsui* were identified on *Cycas revoluta* plants growing in Leon County (USDA zone 8b). The infestations were purposely left uncontrolled in order to observe the effects of freezing temperatures on scale survival. In February 2002 and again in January 2003, nighttime temperatures in Leon County dropped below 20 °F (-6.7 °C) for a minimum of 4 h. Live scale insects were found on leaf samples collected within 24 h of each occurrence of freezing temperatures. The new flush of growth occurring on infested plants in the spring 2002 growing season was quickly covered with a white crust of primarily male insects, typical of Cycad Aulacaspis Scale infestations.**

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This seemed to indicate that the insects were not significantly impacted by the sub-freezing temperatures experienced the preceding winter.

A native of Japan, the King Sago Palm (*Cycas revoluta* Thunb.) is an important landscape plant in subtropical and warm-temperate climates. It is valued for its tropical appearance, architectural form and relatively low maintenance requirements. Its growth range encompasses all of Florida, and extends into southern Georgia, Alabama, Mississippi, Louisiana and Texas. Temperatures in the northern most areas of the King Sago Palm's range regularly drop into the low to mid teens (degrees Fahrenheit) in the colder months. Especially cold temperatures may result in damage to the plant's foliage, but the meristem and trunk typically survive.

In 1996, cycad specimens, including *Cycas revoluta*, growing at Fairchild Tropical Gardens and Montgomery Botanical Center in southern Miami-Dade County were found to be infested with a scale insect later identified as *Aulacaspis yasumatsui*. Populations of the insects quickly reached high densities on the host plants, causing necrosis of the fronds, and eventually death of the plants (Howard et al., 1999).

Initial control methods proved ineffective, and the insects began to spread throughout southern Florida (Weissling et al., 1999). Movement was rapid. By 1997 the scale had spread to northern Miami-Dade County, in 1998 it was well-established throughout Broward County, and in 1999 communities in Palm Beach County were reporting infestations to local agencies. In 2000 nurseries in the Orlando area were finding infested plants in their stock and infested plants were found at the Florida Nurserymen and Allied Trades Show (FNATS) in Orlando. In 1998, insects from heavily infested *Cycas revoluta* plants on the island of Oahu, Hawaii were identified as the Cycad Aulacaspis Scale. Speculation is that the insects were introduced into Hawaii from Florida (Heu and Chun, 1999). The primary means of long-distance movement seems to be through the transportation of infested plant material, while local movement is accomplished mainly through wind dispersal of the immature stage (Weissling et al., 1999).

The Cycad Aulacaspis Scale was first identified as occurring on cycad species in Thailand in 1972 (Takagi, 1977). It was considered a pest, but was typically kept at low densities by natural predators. The rapid spread and unusually high population density of the Cycad Aulacaspis Scale found in Florida suggested that it was imported without any of its natural enemies. In 2002, the USDA-APHIS approved the release species of two genera of parasitic wasps (*Coccobius* and *Encarsia*) and a species of predaceous beetle (*Cybocephalus binotatus*) into the environment in an attempt to control Cycad Aulacaspis Scale (DeHaven, 2002). The Florida Division of Plant Industry (DPI) released approximately 15,000 *Coccobius fulvus* from February-April 2002 in Brevard, Broward, Hillsborough, Indian River, Manatee, Martin, Miami-Dade, Palm Beach, Pinellas, Sarasota and St. Lucie Counties (Hodges et al., 2003).

In early 2001, the Cycad Aulacaspis Scale was positively identified from specimens collected on the campus of Florida A&M University (FAMU) in Tallahassee, Leon Co., Fla. Upon investigation, it was found that the infested plant had only recently been installed into the landscape and had originally come from a nursery in central Florida. Prior to installation in the landscape in Tallahassee, it had not been subjected to winter conditions in northern Florida. Early speculation was that the insect would be limited in its northern movement in the state by cold and freezing weather. The scale is tropical in origin and the thought was that it possibly could not survive temperatures below 32 °F.

Materials and Methods

In May 2001, samples of insects tentatively identified as Cycad Aulacaspis Scale (*Aulacaspis yasumatsui*) were collected from a King Sago Palm plant (*Cycas revoluta*) growing on the campus of FAMU in Tallahassee, Leon Co., Fla. Samples were taken to Dr. F. W. Howard at the University of Florida's Ft. Lauderdale Research and Education Center for positive identification. No prior confirmation of this insect had been made in Leon County and this site constitutes the northern-most reported specimen in the state of Florida (G. Hodges, DPI, personal communication).

The infested plant was left untreated in order to observe the survival of the insect during the winter months when temperatures dropped below freezing. Samples of leaves with attached insects were collected for insect viability testing after each occurrence of freezing temperatures in the winter of 2001-2002 and also in the winter of 2002-2003. Assessments of viability were made between 24 and 48 h after the occurrence of a freeze. Insects were observed under a dissecting microscope to determine viability.

Results and Discussion

Night-time temperatures dropped below freezing several times during December 2001 and January 2002 but stayed above 28 °F. At no time did the temperatures remain below freezing for more than 1 h. No sign of increased insect mortality was noted following these freezes. These freezes were not considered severe or hard freezes due to the temperature reached and the duration of the freeze. On 18 February 2002, night-time temperatures on the FAMU campus dropped to 19 °F and stayed below 20 °F for a two-hour period. Again, no sign of increased insect morality was noted following this freeze.

The winter of 2001-2002 was considered to be relatively mild when compared to an average winter for the Tallahassee area. The mild effects have been attributed to *La Nina*. In an average winter (80-year mean) Tallahassee can be expected to experience 34 d when temperatures drop below 32 °F. Of these days, two can be expected to have temperatures dropping into the mid teens (B. Richards, United States Meteorological Service, personal communication). The first occurrence of freezing temperatures typically occurs in mid to late November, though freezes as early as September have been recorded. Freezing temperatures are not expected after mid-March. In the winter of 2001-2002, there were only 11 d when temperatures dropped below 32 °F and only one occurrence of temperatures in the teens. The 18 Feb. 2002 freeze was the last freeze of the winter.

During 2001 and into winter 2002, the infestation remained limited to the original plant. However, Cycad Aulacaspis Scales were noted on adjacent plants following the spring flush of growth. The plants quickly developed the white crusting typical of severe infestations. Previous work has shown that the insects can reach a density as high as 66.8 insects per 5 cm^2 (Howard et al., 1999). Female insects can reach sexual maturity in as little as 16 d and each can lay an egg mass consisting of 90-110 eggs (Howard et al., 1999).

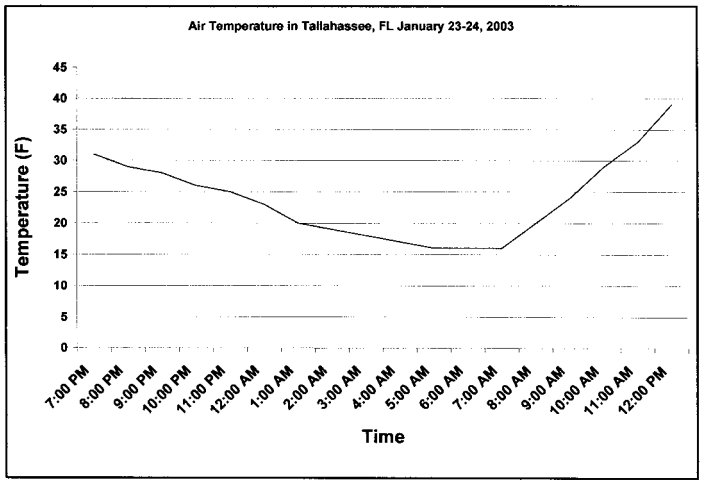

Fig. 1. Hourly air temperatures taken 60 cm (~24 inches) above ground level in Tallahassee, Fla. January 23-24, 2003.

Several freezes occurred in late fall 2002 but the lows reached were of a similar magnitude as those experienced in the preceding fall. In January 2003, Tallahassee experienced a hard freeze which lasted for several hours. On January 23, the air temperature dropped below freezing at approximately 7:00 PM and continued to drop during the night and into the morning of January 24 until a low of 16.7 °F was reached at approximately 6:00 AM. The air temperature remained at this low point until shortly after 8:00 AM, when it began to rise. The temperature remained below freezing until after 11:00 AM (Fig. 1). The infested plants were inspected later in the day of January 24. Severe freeze damage was noted on the plant where the original infestation was noted. No aboveground live leaf tissue could be found. Therefore, leaf samples were collected from a *Cycas revoluta* adjacent to the original plant for assessment of scale viability. Live insects were found on the pinnae of the leaves.

From these observations, we can conclude that the Cycad Aulacaspis Scale are seemingly little affected by long-term (>4 h) exposure to temperatures below 20 °F. Cold temperatures which normally occur in the distribution range of *Cycas revoluta* are not low enough to significantly harm this insect, and the scale's range is probably limited by its host's tolerance to low temperatures rather than its own.

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